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MEGASPOROGENESIS AND MEGAGAMETOGENESIS IN *ALOE AFRICANA* MILL.

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Abstract

The campylotropous ovule of *Aloe africana* has three integuments. During megasporogenesis the megaspore mother cell gives rise to either a T-shaped or a linear tetrad of megaspores. Only the chalazal megaspore remains functional to produce an embryo-sac of the *Polygonum*-type.

Uittreksel

MEGASPOROGENESE EN MEGAGAMETOGENESE BY *ALOE AFRICANA* MILL.

Die kampilotrope saadknop van *Aloe africana* besit drie integumente. Tydens megasporogenese gee die megaspoormoedersel oorsprong aan òf 'n T-vormige òf 'n lineêre tetrade van megaspore. Slegs die megaspoor aan die kant van die chalaza ontwikkel verder. Die embriosak wat aangetref word is van die *Polygonum*-tipe.

Introduction

Aloe africana is found along the Eastern Cape coast from the Gamtoos River near Humansdorp to Port Alfred and Bathurst, and inland as far as Sheldon and Bedford (Jeppe, 1969).

Although the embryology of *Aloe africana* has not yet been described, Gioelli (1930) studied the embryo-sac development in five other species of *Aloe*, namely *A. arborescens* Mill., *A. Todari* var. *praecox* Borzi, *A. caecia* Salm., *A. varvari* Borzi and *A. ciliaris* Haw. In each case he found that the development of the embryo-sac conformed to that of the *Adoxa*-type. In this type of development no separating walls exist between the megaspore nuclei, and all four nuclei divide only once to give rise to a tetrasporic, eight-nucleate embryo-sac. Hence in the *Adoxa*-type development, there are only three divisions between the megaspore mother cell and the mature embryo-sac (Maheshwari, 1950). Joshi (1937) reports that research on other very closely related genera showed the *Polygonum*-type of embryo-sac and consequently he undertook a re-investigation of the embryology of the genus *Aloe*. Davis (1966) also recommends that Gioelli's report (1930) of the *Adoxa*-type embryo-sac requires further investigation, in view of the occurrence of the *Polygonum*-type in *Aloe vera* (Joshi, 1937). Schnarf and Wunderlich (1939) worked on *A. brownii*, *A. humilis*, *A. concinni*, *A. variegata* and *A. ciliaris*, all of which showed the *Polygonum*-type embryo-sac.

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MATERIALS AND METHODS

The material for the study was collected in the Redhouse district near Port Elizabeth during June, 1972 and fixed in Craf II (Sass, 1958). It was dehydrated in an ethyl alcohol/tertiary butyl alcohol series, embedded in paraffin wax (55°C) and sectioned at 10 μm on a rotory microtome as prescribed by Brooks, Bradley and Anderson (1950). The sections were stained in safranin/fast green (Holtzhausen, 1972).

RESULTS AND DISCUSSION

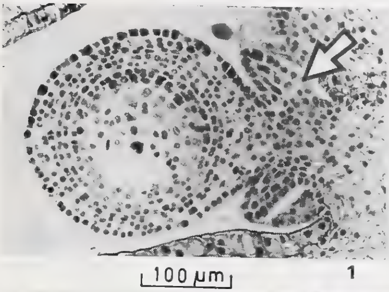
The ovules of *A. africana* were found to remain orthotropous for only a very short while before becoming campylotropous. This is contrary to the condition reported by Joshi (1937) in *A. vera* where the orthotropous condition is maintained for a long time. There are three integuments; the outer one being an aril. Formation of this latter structure is initiated during megasporogenesis and it is fully developed by the time the embryo-sac reaches maturity. The aril, which develops from the funicle, does not grow into a very conspicuous structure and, as is shown in Fig. 1, it constitutes only a small collarlike structure around the funicle of the mature ovule. Joshi (1937) and Schnarf and Wunderlich (1939) observed similar structures in the *Aloe* species studied by them. The inner integument, which forms the micropyle, is usually two cell layers thick while the outer integument is three cell layers thick. Both of these are well-developed, approximately of the same length and extend over two-thirds of the length of the ovule. The nucellus is crassinucellate, having parietal tissue between the megaspore mother cell and the nucellar epidermis (Fig. 2a).

Megasporogenesis

The primary archesporial cell, which originates from one of the nucellus cells, is larger than the surrounding cells, has denser cytoplasm and a more prominent nucleus. This cell functions directly as the megaspore mother cell (Fig. 2a) without any intervening division. After a transverse division, the megaspore mother cell gives rise to a dyad (Fig. 2b). These two cells each divide again, resulting in a tetrad of haploid megaspores (Fig. 2c). The shape of the tetrad varies from linear to T-shaped, and intermediate forms are also found. There is usually no cell wall found between the two nuclei at the micropylar end (Fig. 2c). The chalazal megaspore remains functional to give rise to the embryo-sac, while the three micropylar ones degenerate (Fig. 3). The embryo-sac is thus monosporic.

Megagametogenesis

The single nucleus of the embryo-sac (Fig. 3) divides to form two nuclei which migrate to opposite poles of the embryo-sac (Fig. 4). Each of these



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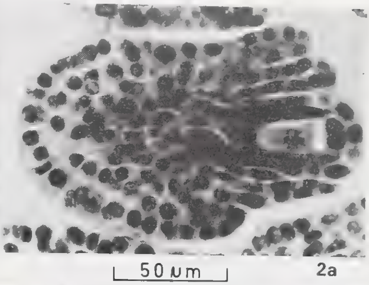

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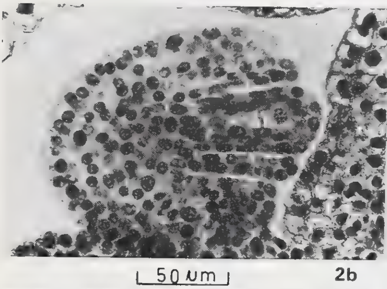

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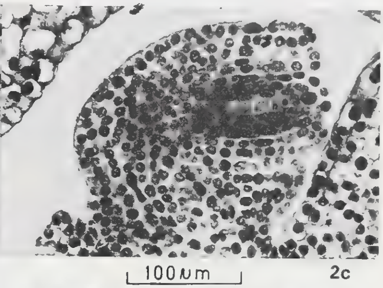

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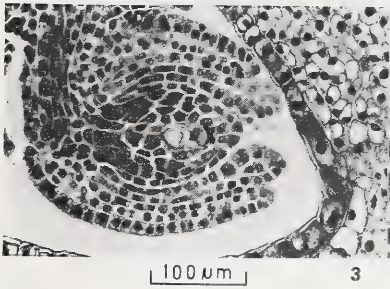

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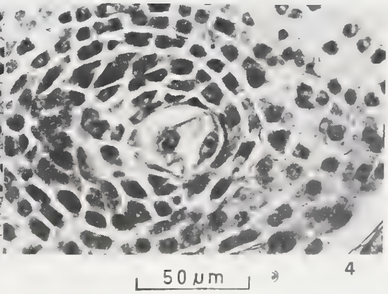

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FIG. 1.

A longitudinal section through the mature ovule of *Aloe africana* showing the aril (arrowed) which develops from the funicle. Note the three antipodal nuclei.

FIG. 2.

Megasporogenesis in *Aloe africana*.

(*a*) A longitudinal section through the ovule illustrating the large megaspore mother cell.
(*b*) The megaspore dyad after the first division of the mother cell.
(*c*) A linear megaspore tetrad. Note the absence of a cell wall between the two micropylar nuclei.

FIG. 3.

A longitudinal section through the ovule of *A. africana* showing the functional megaspore (= uni-nucleate embryo-sac). Note the degenerating megaspores to the right of the embryo-sac.

FIG. 4.

A longitudinal section through the two-nucleate embryo-sac of *A. africana*. (Micropyle to the right.)

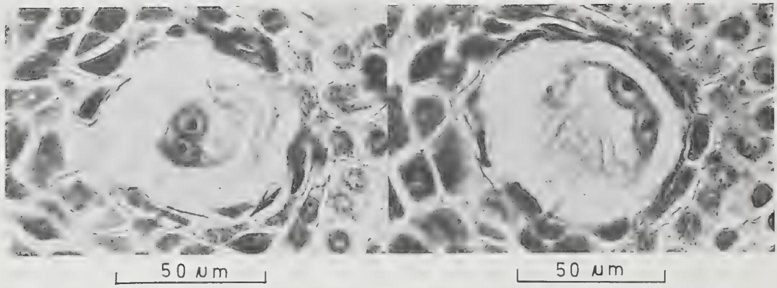

Fig. 5.
Longitudinal section of four-nucleate embryo-sac of *A. africana* showing (*a*) the chalazal and (*b*) the micropylar nuclei.

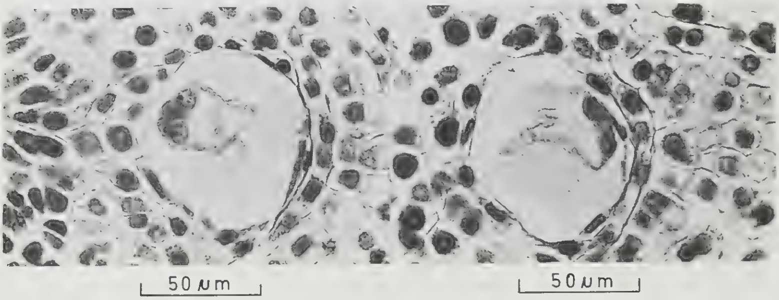

Fig. 6.
A longitudinal section through the eight-nucleate embryo-sac of *A. africana* showing (*a*) the four chalazal and (*b*) two of the micropylar nuclei.

divides again thus giving rise to the four-nucleate stage of the embryo-sac (Fig. 5a, b). After a third free nuclear division, the eight-nucleate stage is reached (Fig. 6a, b). The embryo-sac, being monosporic and eight-nucleate, is therefore of the *Polygonum*-type. In the mature embryo-sac, three of these nuclei aggregate at the chalazal end to give rise to antipodal cells; three at the micropylar end give rise to two synergids and the egg cell, and the remaining two, the polar nuclei, migrate to the centre of the embryo-sac and fuse to form the primary endosperm nucleus (Fig. 7). The antipodal cells persist until after the polar nuclei have fused. Development of the two synergids occurs before fusion of the polar nuclei. No filiform apparatus is present in the synergids.

Conclusions

In general, the results of this study are in accordance with those published by Joshi (1937) and Schnarf & Wunderlich (1939), that is, that the *Polygonum*-type embryo-sac is found in most species of *Aloe*. In view of this, it is suggested that the report by Gioelli (1930) concerning the occurrence of the *Adoxa*-type embryo-sac in species of *Aloe*, be considered with some scepticism.

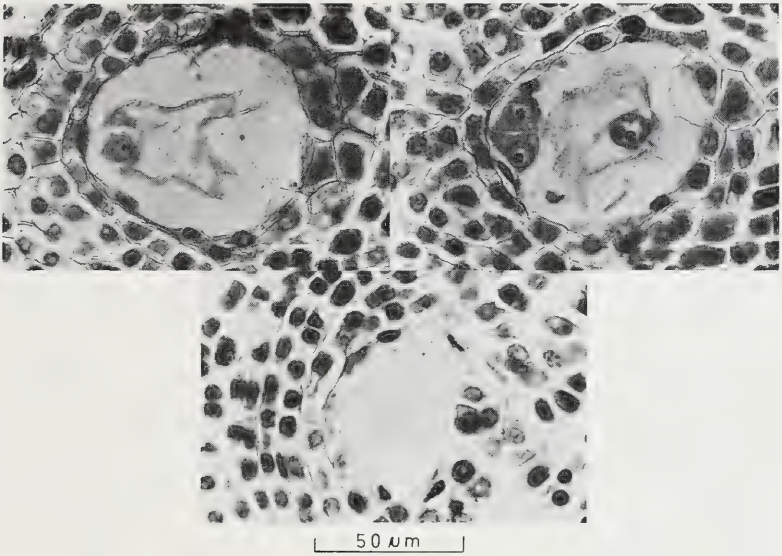

Fig. 7.
The mature embryo-sac of *A. africana* illustrating (*a*) the egg cell, (*b*) the synergids and secondary nucleus (fused polar nuclei) and (*c*) the antipodal cells.

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